



Westport and CWI: Engine Market Analysis Update

NGVTF Technical Committee
April 14-15
Sacramento



Agenda

- ◆ New CWI/Westport Structure
- ◆ Progress Report on NGNGV Project
- ◆ Success Factors for future deployment of Natural Gas Vehicles



The New CWI JV Agreement





CWI – Original JV

- ◆ Original JV formed Mar/01 to explore a range of alternate fuel product and technology opportunities:
 - Mid-Range Engines
 - ◆ Advanced Lean-Burn Spark Ignited Engines for bus and MD Truck
 - ◆ International market opportunities
 - HD Truck
 - ◆ HPDI for North American HD truck
 - ◆ Concentrated in CA and TX
 - High Horsepower
 - ◆ Power generation and Industrial
- ◆ Westport invested over \$50 million in first 3-years of the JV
- ◆ Cummins and Westport agreed to review JV progress at end of 2003 and decide how to proceed





The New, Permanent CWI

- ◆ CWI initially focused on selling spark ignited Mid Range natural gas and propane engines into global truck and bus markets:
 - B Gas Plus (195-230 hp) 2002 Launch
 - B LPG Plus (195 hp) 2003 Launch
 - C Gas Plus (250-280 hp) 2001 Launch
 - L Gas Plus (320 hp) Fall 2004 Launch
- ◆ CWI will be self sustaining and will finance growth through its own operations
- ◆ CWI will bring to market, now and in the future, best available technologies engineered into Cummins line of engine products





Westport Innovations Inc.

- ◆ New market development & demonstration initiatives
 - HD Truck (with HPDI)
 - HCNG demonstrations...
- ◆ Next generation technology programs
 - MD Truck with Hot Surface Ignition
 - Direct Injection fuel systems
 - Hydrogen combustion



Technology Partnership Agreement (TPA)





Technology Partnership Agreement

- ◆ A mechanism to facilitate collaborative technology development between Cummins and Westport
- ◆ Includes development of supporting technologies that may apply to future diesel or gaseous fueled engines (eg. after-treatment, controls etc.).
- ◆ Advisory Board established with senior representation from both Cummins and Westport :
 - John Wall, Chief Technical Officer, Cummins
 - Wayne Eckerle, Exec. Director, Advanced Engineering, Cummins
 - Mike Gallagher, Chief Operating Officer, Westport
 - Patric Ouellette, Chief Technical Officer, Westport



NGNGV Phase 1, Task B Preliminary Vehicle Design Development



Project Overview

Objective:

- ◆ Develop preliminary designs and market introduction strategies for two medium-duty (Class 3-6) or heavy-duty (Class 7-8) trucks that are fueled with LNG or CNG and achieve 0.5 g NOx emissions

Methodology:

- ◆ Identify candidate vocations, chassis, & engines, and establish profiles of each (complete)
- ◆ Perform life-cycle cost analysis of candidates, in order to select two preferred vocation/chassis/engine (in progress)
- ◆ Develop design concepts and market introduction strategies for two selected candidates (pending)



Candidate Vocations & Engines

Candidate Vocations

◆ Heavy duty

- Refuse Collection/Transfer
- Food / Beverage
- Package Delivery
- Bulk Hauling

◆ Medium duty

- Government / Utility
- Pick-up & Delivery
- Food / Beverage

Candidate Engine Platforms

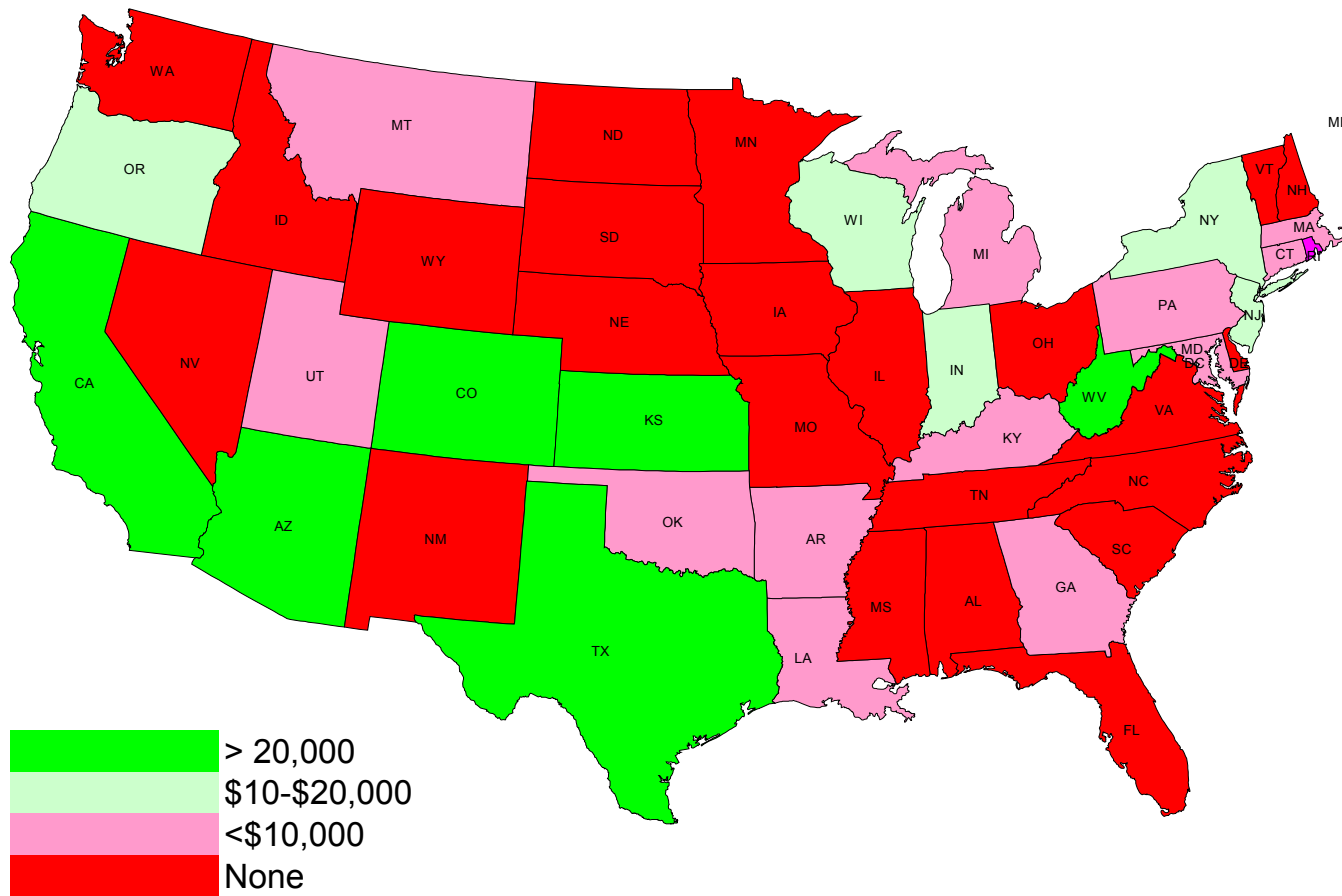
- ISX G (15 L)
- L Gas (8.9 L)
- B Gas (5.9 L)
- C Gas (8.3 L)
- L Gas (8.9 L)

- ◆ LNG contract prices of surveyed fleets ranged from \$0.89 to \$1.26 /DEG before tax
- ◆ Federal Tax \$0.20 /DEG

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HD Truck Incentives





MD & Refuse Truck Market Potential

MD Truck

- ◆ Approx. 130K unit sales / year
- ◆ Very little NG penetration to date
- ◆ Interest in NG beginning to come from government / utility sector
- ◆ Significant NG market penetration is expected to rely on establishing economic value proposition

Refuse

- ◆ Approx. 7500 unit sales / year
- ◆ NG penetration is small but growing
- ◆ Additional penetration expected with availability of higher powered engines (e.g. L Gas Plus)

Class 8 Tractor Market Potential



1.5 million Class 8 trucks registered in U.S.:

- 40% travel > 75,000 miles per year
- 75% travel < 500 miles per trip
- 13% registered in California and Texas

Assuming 10 year turn, CA & TX market potential can be estimated as:

$$(1.5 \text{ million trucks}) \times 40\% \times 75\% \times 13\% \times (1/10 \text{ years}) \\ = \text{Approx. 6,000 trucks per year (CA \& TX only)}$$

Source: Data for trucks > 50,000 lbs average vehicle weight and > 45' in length
United States 1997 Economic Census
Vehicle Inventory and Use Survey, Issued October 1999
U.S. Department of Commerce, Economics and Statistics Administration
<http://www.census.gov/svsd/www/97vehinv.html>



Bus Market Potential

Urban Bus

- ◆ Approx. 4,000 unit sales / year in U.S. (40' bus)
- ◆ Approx. 20-25% NG market share currently
- ◆ Increasing NG share will require continued policy leadership, and availability of increased power (e.g. L Gas Plus).

Shuttle Bus

- ◆ Approx. 14K unit sales / year in U.S.

School Bus

- ◆ Approx. 30K unit sales / year in U.S. (Type C & D only)
- ◆ Approx. 1-2% NG market share currently



Westport Observations and Recommendations for Low-emission HD Trucks



Westport's Position on HD

- ◆ Westport has invested in development of HPDI for heavy-duty applications
- ◆ Market conditions did not support product launch in 2004 as anticipated
- ◆ Westport is evaluating long-term potential to accelerate introduction of a 0.2 gram NOx product in 2007/08
- ◆ Continued investment is contingent upon stakeholder support, funding and incentives





Market Requirements

- ◆ New technology must have same or better utility (torque, power, range, operational)
- ◆ New technologies must have same or lower lifecycle cost as mainstream technology (diesel)
- ◆ Any incremental upfront cost must have guaranteed max. payback time of 2-3 years
- ◆ Availability of fuel at lower than diesel pricing
- ◆ Significant volumes needed to realize cost targets
- ◆ Secondary market required for some customers/vocations
- ◆ Positive, long-term commitment from government agencies signaling accelerated adoption of low-emissions solutions and energy security



Recommended Tax Measures

- ◆ Fuel Tax reform - standardize state fuel taxes so they all use energy-equivalent basis for tax
- ◆ Reduce or eliminate Federal fuel tax on alt fuels (LNG is different than CNG, and is only marginally less tax than diesel)
- ◆ Eliminate Federal and State sales tax on incremental capital cost of alternative fuelled vehicles. Consider reduced sales tax on entire vehicle capital cost. Current combined sales tax is approx. 20% on gross incremental cost.



Fuel Infrastructure Support

- ◆ Provide incentives for private and public-access refuelling facilities
- ◆ Fund cost-reduction projects for station design and standardization
- ◆ Encourage fuel production facilities near customers (provide repayable capital, ease permitting, etc.)
- ◆ Support LNG import terminals that will provide *low-cost* LNG for transportation uses



Customer Incentives

- ◆ Emission reduction incentives (\$/ton for NOx, PM, GHG, etc.)
- ◆ Energy Security incentives (\$/gal savings for reducing dependence on petroleum imports)
- ◆ Encourage leasing options for alt. fuel vehicles that provide same or lower \$/mile costs to end-users (leasing option eases customer use of alt. fuel)

Support for NG HD Would deliver...



- ◆ NOx/PM benefits
- ◆ GHG benefits
- ◆ Path to petroleum independence
- ◆ Expansion of LNG in N.America
- ◆ Legacy fleet of new ultra-low emissions vehicles
- ◆ Leadership



Summary

- ◆ CWI now focused on SI Mid Range sales, with HD HPDI under Westport (and the Westport-Cummins TPA)
- ◆ Westport believes there could be a compelling market for clean HPDI HD trucks in the 2007-08 timeframe if:
 1. Significant incentive funding with operational flexibility (inter-jurisdictional boundaries, etc.) is secured
 2. LNG is widely available at lower than diesel pricing
 3. Sales tax on incremental cost is reduced or eliminated
 4. Sufficient truck volumes realized to reduce initial cost
 5. Funding to support 0.2g NOx technology and product development
 6. OEM support for heavy-duty natural gas vehicles

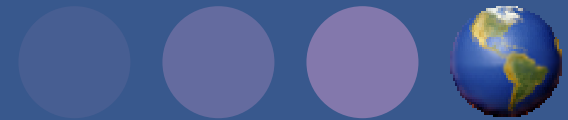


Today's Challenge's Tomorrow

- ◆ Largest Barriers to Natural Gas in Vehicles Today
 - Infrastructure, LCC, and Customer Acceptance

- ◆ Largest Barriers to Hydrogen Tomorrow
 - Likely Infrastructure, LCC, and Customer Acceptance

- ◆ CNG Today does five things
 - Better Emissions
 - Energy Independence
 - Develops Gaseous Fuel Expertise
 - Builds National Infrastructure for Gaseous Fuel
 - Helps Improve LCC and Customer Acceptance



Future of Natural Gas Engine Market

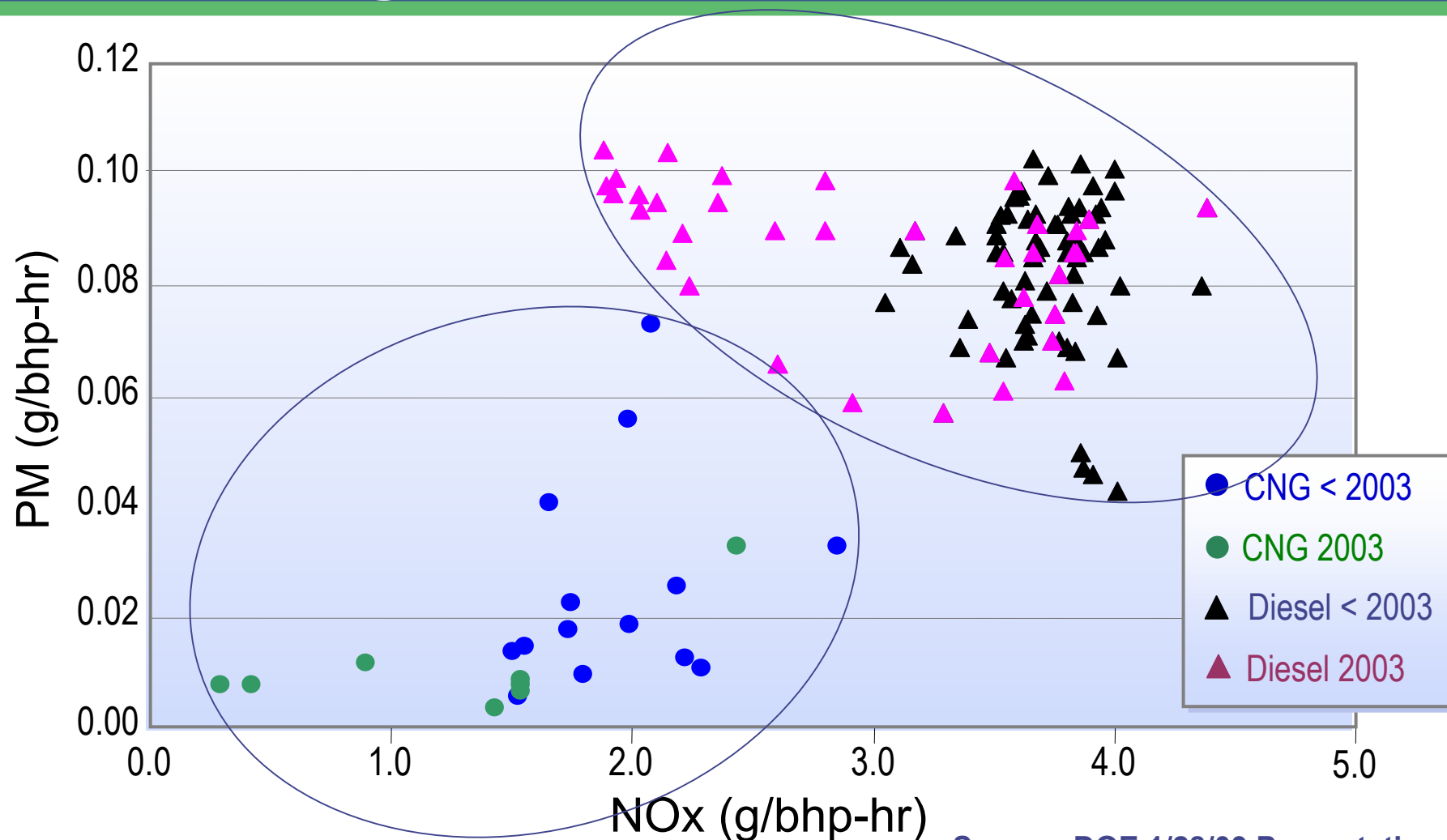
We have the technology

We need industry-wide support

A compelling level of support will drive
investment towards National energy security and
environmental goals



Today's Diesel and NG Engine Emissions



Source: DOE 1/28/03 Presentation



Continue Investment in R&D

- ◆ R&D should not stop at 0.2g/bhp-hr....
- ◆ The natural gas paths chosen have placed natural gas engines on a path to near-zero emissions levels.
- ◆ In 2010 diesels should be at 0.2g/bhp-hr. Natural gas and hydrogen (singly or mixed) engine development should continue to reach goals 0.1 g/bhp-hr, 0.05g/bhp-hr etc.
- ◆ If investment in these ultra-low levels does not happen now at the research level, advanced engineering and product development will not flow out of them.



Continue Investment in R&D

- ◆ The fuel cell is a long way off and industry needs super-clean urban transportation technologies that can use non-petroleum and lower carbon fuels like natural gas and hydrogen.
- ◆ These engines can eventually integrate with hybrid vehicle technology to boost energy efficiency, reduce noise pollution in urban environments, improve driveability etc.